

Approaches for excessive gingival display (gummy smile) treatment

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Abstract. Objective. Gummy smile is considered non-pathological, but inaesthetic. Treatment methods are chosen on etiology and patient preferences criteria. Patients tend to opt for quicker, less invasive treatments, so this review aimed to summarize recent literature on gummy smile treatment methods, excepting orthognathic surgery or orthodontics. Materials and methods. Three databases were searched: PubMed, Scopus and Web of Science. Search development, process, and the two-step article selection were conducted by independent researchers. Data was extracted regarding study characteristics, population and excessive gingival exposure before and after treatment. This information was subsequently summarized. Results. Out of 544 results, 51 were selected for reviewing. The studies were classified according to treatment methods: botulinum toxin A injections, surgical lip repositioning, crown lengthening, hyaluronic acid injections, gingivectomy and others. The particularities, advantages and disadvantages of each treatment were discussed. Conclusions. The recent literature reveals a growing interest in quick, less-invasive surgical methods or minimally invasive non-surgical methods in treating gummy smile. Further longitudinal studies could provide data for predictable outcomes, increasing availability and optimizing treatment strategies for excessive gingival display.

Key Words: excessive gingival display, gummy smile, minimally invasive treatment options, lip repositioning, botulinum toxin A

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Introduction

Gummy smile, also known as excessive gingival display, is a condition considered a non-pathological condition which occurs when a person smiles, and a significant portion of their gum is exposed. This can be perceived as aesthetically displeasing by some individuals. A gummy smile is defined as showing more than 2 millimeters of gum tissue when smiling. According to Diaspro et al. (2018) the prevalence of gummy smile is higher in women and decreases with age.

A gummy smile can be classified based on various factors including etiology and the extent of gingival exposure. According to a study by Venugopal et al (2024) the quantitative classification of the gummy smile is based on the severity of excessive gum display, and it typically falls into categories of mild, moderate, or severe. A mild gummy smile involves 2-4 millimeters of excessive gum display, a moderate gummy smile involves 4-8 millimeters, and a severe gummy smile involves more than 8 millimeters of excessive gum display. Additionally, as stated by Monaco et al. (2004), gummy smiles can also be classified based on etiopathogenetic factors into dento-gingival, dento-alveolar,

muscular or mixed gummy smile, depending on the underlying conditions that contribute to the excessive gum display.

The causes of the gummy smile can vary and may include hereditary, congenital, or acquired factors. Some specific causes of a gummy smile may include excessive vertical growth of the maxilla, skeletal cants, excessive eruption of maxillary anterior teeth, dental cants, disproportionate crown length and width of anterior teeth, severe proclination of the maxillary anterior teeth, excessive contraction of the upper lip, gingival enlargement, reduced length of the upper lip, and altered passive eruption. Infection-related gingival enlargement and medication-induced gingival enlargement can also contribute to a gummy smile (Venugopal et al 2024).

In order to have an accurate diagnosis, Dym And Pierre (2020) suggest that the following should be considered: patient history, facial analysis, static and dynamic lip analysis, dental analysis and muco-gingival analysis.

According to Zengiski et al. (2022) treatment approaches for a gummy smile should be categorized based on specific etiologies and include the following: periodontal surgery (gum contouring

or gingivectomy, surgical crown lengthening) for excessive gingival growth or altered passive eruption, orthognathic and plastic surgery which includes Le Fort I impaction for skeletal defects, and lip repositioning, Botox injections, hyaluronic acid injections and micro autologous fat transplantation, which can be used in various etiologic backgrounds. In addition, orthodontic treatment options include orthodontic intrusion of the maxillary anterior segment for dental-alveolar extrusion, orthodontic intrusion of the whole maxillary arch for dental-alveolar extrusion, retraction of proclined incisors for a better or more relaxed lip fall, orthodontic intrusion of the canted segment to correct asymmetric high gingival smiles (Diaspro *et al.*, 2018). As stated by Say and Thomsom (2003), patient preferences for treatment are an important aspect to take into consideration, for a successful and predictive treatment process and outcome. Nowadays most of patients tend to opt for treatments which do not involve hospitalization or post-surgical recovery, which show immediate results and are less invasive, even if the results might be temporary or present the possibility of relapse. It's crucial to discuss treatment options with the patient and accurately assess their expectations of the treatment parcourse.

In this context, one aim of this review was to provide a comprehensive view of the most recent studies available in literature about excessive gingival display treatment approaches and methods, apart from orthognathic surgery or orthodontic treatment. in addition, a second objective was to identify and summarize contemporary treatment alternatives to orthognathic surgery or orthodontic treatment.

Materials and methods

This study and its protocol were based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guideline extensions for abstracts and for scoping reviews (PRISMA-ScR) (Page *et al* 2020, Trico *et al.* 2018).

1. Question of study

This review was designed to answer the following question: "What are the currently available treatment methods (excluding orthognathic surgery or orthodontic treatment) for excessive gingival display?"

2. Eligibility criteria

a. Inclusion criteria

The inclusion criteria of this systematic review were organized according to the PICOS strategy.

P (population) = adult patients with permanent dentation and gummy smile, without other dento-skeletal or general pathologies

I (intervention) = clinical interventions targeted to reducing gingival exposure during smiling

C (control) = ideal gingival exposure during smiling

O (type of outcome measures) = gingival exposure post-treatment (mm), patient satisfaction levels

S (type of studies) = original studies on adult humans, observational studies of both retrospective and prospective design, clinical studies, interventional studies (case reports, case report series, controlled clinical trials)

Other inclusion criteria:

-Studies published in the last 5 years before search conclusion (05.06.2019-05.06.2024)

-Studies published in English

b. Exclusion criteria

The following exclusion criteria were applied:

-Studies targeting pediatric populations

-Studies using orthognathic surgery, ortho-surgical methods or orthodontics as main treatment methods

-Study designs: literature reviews and/or meta-analyses, editorials, conference abstracts

-Studies on animals, cadavers or in-vitro studies

-Studies not available full text

-Studies with missing or incomplete data on excessive gingival exposure before or after the intervention

-Studies published in other languages than English.

3. Search strategy

An electronic search was conducted in the following databases: PubMed, Scopus, Web of Science. The electronic literature search was developed and conducted by independent researchers. The electronic search was performed until 05.06.2024 to identify relevant articles. The search consisted of keywords for gummy smile and treatment, combined with Boolean operators "AND" and "OR", as well as keyword searching of title, abstract and text words. Date restrictions were applied: from 05.06.2019 to 05.06.2024 (the last date of search). Restrictions regarding language (English) and species (humans) were applied. The exact search terminology used in PubMed was:

excessive gingival display OR "excessive gingival display" OR "gummy smile"[tw]) AND (treatment[tiab] OR therapy[tw])

These terms were used as search query in the other two databases, with adequate modifications to comply with each database's-controlled vocabulary and search filters.

4. Study selection process

Search results from all databases were downloaded and centralized using a reference manager software (Mendeley Version 2.116.0). The duplicates were then identified using the same software. A second de-duplication software was used to confirm the previous identified duplicates (The Systematic Review Accelerator (SRA), developed by Bond University, Queensland, Australia) (8). Remaining articles were screened (by title and abstract) using inclusion and exclusion criteria by two contributors to the article. Studies considered relevant were manually retrieved in full-text form and read by two researchers. The inclusion and exclusion criteria were applied again to obtain the final number of included studies. Any conflicts were settled by consulting a third researcher. The level of agreement between researchers was calculated by the Kappa coefficient (value: $k = 9.20$).

5. Data extraction

The following data was extracted from the included studies:

-General data about the studies (title, main author, geographic area, year of publication, study design, treatment method evaluated)

-Population (number of subjects, age/gender distribution)

-Exposure and controls (height of gingival exposure before and after intervention)

The studies were then grouped according to the described treatment method. The characteristics, advantages and disadvantages of each method are detailed in the results section of the review.

Results

1. Study selection

The search retrieved a total of 544 results (95 from PubMed, 152 from Scopus and 279 from Web of Science). After de-duplication, 165 articles were removed. After screening the articles' titles and abstracts, the 2 examiners (CA and CC) excluded 276 articles based on the inclusion and exclusion criteria. The remaining 97 articles were sought for retrieval in full text, out of which 18 were unavailable for retrieval. The 79 remaining articles were read in full-text form by two examiners, with a third available as additional decisive factor when needed. Several (28) studies were excluded on premises of exclusion criteria, resulting in a number of 51 articles to be included in this review. The study selection process is summarized in the following PRISMA 2020 flowchart.

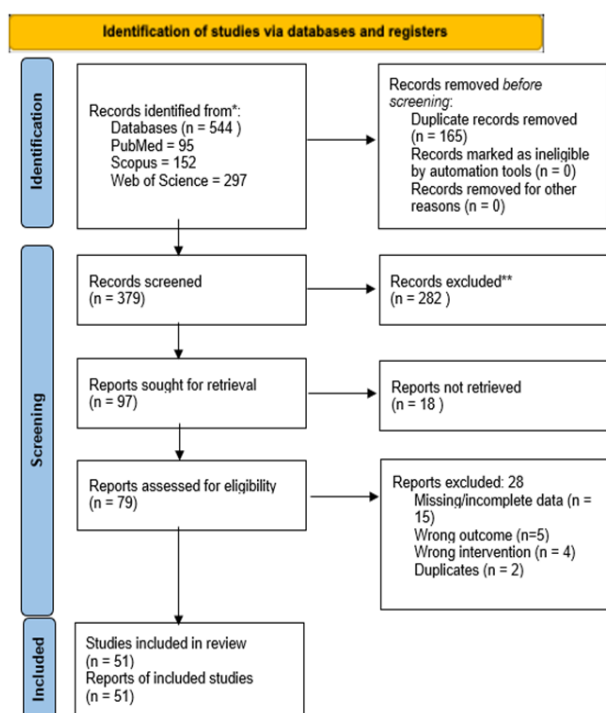


Fig. 1: Prisma flowchart of study selection

2. Description of included studies

a. Studies on Botulinum toxin A injections

We identified 16 studies on Botulinum toxin A usage in gummy smile treatment, out of which 7 are clinical trials, 7 are clinical studies and 2 case reports. The clinical studies and trials included between 10 and 94 participants. The studies and data extracted are summarized in Table 1.

b. Studies on surgical lip repositioning

24 studies investigating lip repositioning procedures were included, of which 4 clinical trials, 3 clinical studies, 7 case series and 10 case reports. The clinical studies and trials included between 8 and 200 participants, while case series numbered between 2 and 24 cases. The studies and data extracted are summarized in table 2.

c. Studies on crown lengthening

4 studies investigating crown lengthening procedures were included in this review, 2 clinical trials and 2 case reports. The

clinical trials included 20 and 36 patients. The studies and data extracted are summarized in table 3.

d. Studies on hyaluronic acid injection

Two studies on hyaluronic acid injections were included, a case report and a clinical evidence study. The study by Mercado-Garcia et al (2021) was included despite not reporting initial and post-intervention values of gingival exposure, due to being presented as conclusion and a clinical guide of several studies by the authors. The studies and data extracted are summarized in table 4.

e. Studies on gingivectomy

Two studies using gingivectomy as main treatment method were identified, a clinical study of 24 participants and a case series of 6 cases. The studies and data extracted are summarized in table 5. Table 5 Summary and characteristics of included studies on gingivectomy.

f. Other methods

Three studies were identified and included, which used other methods than the previously mentioned categories. They were listed together as didn't fit in with the classification used. These included two case report and a clinical study on 3 patients. The studies and data extracted are summarized in table 6.

Discussions

1. Main findings

Beauty is a relative and deeply subjective concept, whilst existing as a sum of individual factors such as personal perception, social influences, cultural factors, education, gender and many more, all of which make its standardization impossible. While social networking and mass-media influence beauty perceptions on a global scale, dental practitioners find themselves leaning more to the aesthetic aspect of dentistry, as per patients' demands. According to Waldrop et al. (2008) gummy smile is a non-pathological entity, but its prevalence and aesthetic impact make it noteworthy.

Considering the dental professionals' objectives of treatment might not overlap to patients' expectations of the process and results, understanding the patients' priorities, desires and preoccupations is just as important as settling realistic and achievable treatment objectives. Hence, the dental professional must be up to date with novel treatment approaches and various treatment options available for excessive gingival display, to be able to balance aesthetic demands and optimal functionality in the parameters desired by patients.

Due to various etiologies, gummy smile treatment options can be difficult no navigate. Therefore, the first essential step to treatment success is to correctly identify the cause of excessive gingival display (Bynum et al., 2016). Modern and less invasive techniques have arisen as an alternative to the more traditional surgical techniques, because of ongoing advancements in both medicine and technology. Patients now prefer less complicated, oftentimes reversible treatments to avoid the discomfort and potential complications of invasive surgical procedures or treatments that involve long timespans, such as orthodontics. However, not all treatment options are available in all cases, as Jaramillo et al.(2023) concluded. Orthognathic surgery is still

Table 1. Summary and characteristics of included studies on botulinum toxin A injections (Botox)

Nr	Main author	Year published	Geographic area	Study design	Study population	Age/gender distribution	Initial gingival exposure (mm)	Post-intervention gingival exposure (mm)	Notes
1	Adel N et al.	2022	Cairo, Egypt	Clinical Trial	20	F, age range 25-45	5.07 ± 0.35 mm	14 days: 0.00 ± 0.00 mm; 4 months: 4.62 ± 0.98 mm; 8 months: 4.88 ± 0.38 mm; 12 months: 5.04 ± 0.37 mm	
2	Andriola F O et al.	2021	Brazil	Clinical Trial	15	21-40 years old, 86.7% F	5.43 ± 1.23 mm	1 week: 1.98 ± 0.98 mm; 6 months: 3.95 ± 1.25 mm (26.6% still <3 mm GD)	
3	Cengiz A et al.	2019	Turkey	Clinical Trial	28	7M/21F, 22.11 ± 4.55 years	2-8 mm	NA	Botulinum toxin type A injected in the levator labii superioris compared to orbicularis
4	Costa A B et al.	2022	Not specified	Clinical Trial	20	18F/2M, age range 19-38	4.8mm	2 weeks: 0.8mm 8 weeks: 0.9mm 12 weeks: 2mm 16 weeks: 2.3-3.1mm 21 weeks: 2.5-3.7mm 25 weeks: 3.7-5mm	
5	Dutra et al.	2020	Not specified	Clinical Trial	38	32F/6M, age range 20-45	4-6 mm	0-2 mm	Comparison of botulinum toxin and orthognathic surgery
6	Gong J et al.(39)	2021	China	Clinical Trial	94	77F/17M, age mean 27 years	6.3 mm	2 weeks: 3.9mm 12 weeks: 4.7mm 32 weeks: baseline	
7	Hexsel D et al.	2020	Brazil	Clinical Study	41	39F/2M, age mean 37.2	4-6 mm	4 weeks: 2-3 mm	Effects of different doses of Botulinum toxin
8	Mate M et al.	2021	India	Clinical Study	10	7F/3M, age range 18-35	4-10 mm	2 weeks: 2-5	Clinical and electromyographic evaluation of botulinum toxin
9	Rajagopal et al.	2021	India	Clinical Study	32	Mixed gender, age range 18-40	3-8 mm	1-2.5mm	Effect and longevity of Botulinum toxin type A
10	Skaria J et al.	2021	India	Clinical Study	20	NR, age range 18-40	4.93±-0.68 mm	3.63 ±- 0.52 mm	
11	Soris R et al.	2022	Not specified	Clinical Study	15	10F/5M, age range 18-40	6-8 mm	2-4 mm	
12	Shemais N et al.	2021	Cairo, Egypt	Randomised clinical trial	25	23F, 2M, age mean 25	5.75 ±- (0.62) mm	2.4 ±-(0.91) mm	effect of botulinum toxin A in patients with and without zinc supplementation
13	Ashekhi A et al.	2021	UAE	Clinical Study	37	3 males and 34 Fs, age range 19-41	6-9 mm incisor region, 5-7 mm buccal region	After: 1.2-2 mm (incisor region), 1-1.6 mm (buccal region)	
14	Gupta N et al.	2019	India	Clinical Study	10	Age range 18-27	7.5 ± 1.35 mm	3.2 ± 0.91 mm	
15	Goncalves MA et al	2021	Brazil	Case Series	3	19,28 and 32 years old, F	>3mm	NR	
16	Dall'Magro A et al.	2024	Not specified	Case Report	1	21-year-old F	5 mm	Complete resolution	

Table 2. Summary and characteristics of included studies on surgical lip repositioning

Nr	Main author	Year	Geographic area	Study design	Study population	Age/gender distribution	Initial gingival exposure (mm)	Post-intervention gingival exposure (mm)	Notes
1	Adel, N. et al	2023	Cairo, Egypt	Experimental study	10	F, age range 25-37	5.12 ± 0.52 mm	14 days: 0 mm; 4 months: slight relapse; 8 months: stable; 12 months: slight relapse	Botulinum toxin injections and lip repositioning surgery
2	Adel, N. et al	2024	Cairo, Egypt	Randomized Controlled Clinical Trial	20	F, age range 25-37	4.12 ± 0.52 mm	14 days: significant reduction; 3 months: complete relapse for standard technique group; slight regain for dual-layered suturing group; 6 months: complete relapse for both groups	Modified lip repositioning surgery with and without dual-layered suturing
3	AlJasser R et al.	2023	Not specified	Clinical Trial	200	F, NR	5.273 mm (control) 5.369 mm (test)	1 month: 2.274 mm (control), 2.351 (test) 6 months: 2.274 mm (control), 2.351 (test) 1 year: 3.774 mm (control), 2.486 mm (test)	Modified approach in lip repositioning surgery
4	Dawadi A et al.	2023	Nepal	Clinical Trial	14	13F/1M, age range 20-30 years	4.21±0.42 mm	1.07 ± 0.82 mm	
5	Hakobyan A et al.	2022	Not specified	Clinical Study	48	27F,21M, age range:18-43	2-8 mm	83% to 89.7% reduction	
6	Hazzaa A M et al.	2022	Egypt	Clinical Trial	20	14F/6M. mean age 30	4.3 mm	1.6-2.7mm	Modified lip repositioning
7	Namburi R et al.	2022	India	Clinical Study	8	6F,2M, age range: 22-28 years	5.28±1.06	3 months: 2.63±0.52 mm	Mucosal coronally positioned flap
8	Flórez N et al.	2022	Not specified	Case Series	2	2F, 43 and 46 years	8 mm	NR	Laser-assisted lip repositioning surgery
9	Horn R et al.	2022	Brazil	Case Series	11	10F/1M,	Mean 5.48 ± 0.98 mm	Mean 1.04 ± 0.99 mm at 6 months	Lip repositioning technique using polyester threads
10	Haddadi P et al.	2021	Iran	Case Series	3	3F, 28,34 and 24 years	5-6 mm	NR	
11	Puri SS et al.	2022	India	Case Series	3	F, age range 17-25	11.05 ± 2.89 mm	2.86 ± 2.12 mm	
12	Suh J et al.	2020	Not specified	Case Series	24	22F/2M, age mean 30.6 +- 7.2 mm	6.18 +-1.96 mm	2.39 +- 1.39 mm	Er,Cr:YSGG laser-assisted lip repositioning
13	Vergara-Buenaventura A et al.	2020	Not specified	Case series	8	7F,1M, age range: 30 +- 5.94	4.75 +-1.49 mm	3 months: 0.5+- 0.75 mm	Lip repositioning with botulinum toxin-A
14	Zardawi F et al.	2020	Not specified	Case series	4	23 F	5-7 mm	2-3 mm	Various surgical procedures
15	Bilichodmath S et al.	2019	Not specified	Case Report	1	25-year-old F	> 4 mm	1-2 mm	Lip repositioning with myotomy
16	Bouguezzi A et al.	2020	Tunisia	Case Report	1	24-year-old M	7-8 mm	3 mm	Mucosal coronally positioned flap technique
17	Chopra P et al.	2019	India	Case Report	1	22-year-old F	4-6 mm	1-2 mm	LipStaT technique
18	Bhimani RA et al.	2019	India	Case Report	1	23-year-old M	8 mm	2 mm	Lip repositioning, aesthetic crown lengthening, and gingival depigmentation
19	Foudah A	2019	Saudi Arabia	Case Report	1	25-year-old F	7 mm	NR	
20	Ganesh P et al.	2019	NR	Case Report	1	25-year-old F	7 mm	2-3 mm	Laser-assisted lip repositioning and crown lengthening
21	Martínez, A et al.	2022	NR	Case Report	1	29-year-old F	4 mm	NR	LipStaT® technique, 940 nm diode laser
22	Salihu L et al.	2024	Not specified	Case Report	1	27-year-old F	4 mm	NR	Lip repositioning surgery
23	Thaker DD et al	2019	Ahmadabad, India	Case report	1	F, 37	10mm	1 week: <1 mm	Pericol® membrane used
24	Vijayarangan A et al.	2022	India	Case Report	1	18-year-old F	5 mm	NR	Modified lip repositioning technique with 3-year follow-up

Table 3. Summary and characteristics of included studies on crown lengthening

Nr	Main author	Year published	Geographic area	Study design	Study population	Age/gender distribution	Initial gingival exposure (mm)	Post-intervention gingival exposure (mm)	Notes
1	Altayeb W et al.	2022	Not specified	Clinical Trial	36	14M, 22F, age range 22-45	≥ 3 mm	Tissue rebound at 9 months: 0.25 ± 0.3 mm	Laser-assisted esthetic crown lengthening (ECL)
2	Ho D et al.	2022	Vietnam	Clinical Trial	20	19F/1M, age mean 24.67 ± 3.44	5-7 mm (assessed individually/ frontal teeth)	2-3 mm	Combination of clinical crown lengthening surgery and botulinum toxin type A injections
3	Alhumaidan A et al.	2020	Dammam, Saudi Arabia	Case report	1	22, F	4 mm	NR	3D-Printed surgical guide for crown lengthening
4	Yeh Y T et al.	2021	USA	Case Report	1	25-year-old F	6-8 mm	Not specified	Recurrent gummy smile management

Table 4. Summary and characteristics of included studies on hyaluronic acid injections

Nr	Main author	Year published	Geographic area	Study design	Study population	Age/gender distribution	Initial gingival exposure (mm)	Post-intervention gingival exposure (mm)	Notes
1	GermaniVieira et al.	2022	Not specified	Case report	1	36, M	3.3 mm	NR	Myomodulation using hyaluronic acid fillers
2	Mercado-García et al.	2021	Mexico	Clinical Evidence Study	-	-	NR	NR	Gummy Smile Mercado-Rosso Classification System

Table 5. Summary and characteristics of included studies on gingivectomy

Nr	Main author	Year published	Geographic area	Study design	Study population	Age/gender distribution	Initial gingival exposure (mm)	Post-intervention gingival exposure (mm)	Notes
1	Silva G et al.	2022	Not specified	Case Series	6	6F, age mean 23.17	assessed individually / frontal teeth	assessed individually / frontal teeth	
2	Mossaad et al.	2021	Not specified	Clinical Study	24	24 F, age range 25-35	5.17 ± 0.9 mm	1.89 ± 0.5 mm	Diode laser gingivectomy

Table 6. Summary and characteristics of included studies on other treatment methods

Nr	Main author	Year published	Geographic area	Study design	Study population	Age/gender distribution	Initial gingival exposure (mm)	Post-intervention gingival exposure (mm)	Notes
1	Castro L F et al.(75)	2022	Brazil	Case Report	1	25-year-old, F	6 mm	Significant reduction (exact mm not specified)	3D-printed PMMA implant with VISTA technique
2	Bojanowski K et al.(76)	2020	USA	Clinical Study	3	NR	NR	2-3 mm relaxation of upper lip levator muscles	Non-invasive myorelaxant approach using a bioadhesive intraoral patch
3	Krismariono, A. et al (77)	2020	Indonesia	Case report	1	F, 24	10mm	NR	Triangular frenotomy

considered the best option in for treating severe vertical maxillary excess; for mild vertical maxillary excess or short upper lip, lip repositioning surgery and orthognathic surgery are both appropriate; hypermobility of the upper lip can be treated with botulinum toxin type A injection; passive altered eruption can be treated with coronary elongation and apical repositioning flap; gingival hyperplasia can be treated with gingivectomy (Jaramillo et al.2023, Bastidas, 2021).

By revising the literature on the subject, important research has been conducted with increased frequency about gummy smile treatment options, in order to demonstrate the efficacy, safety, side effects, and lifespan of treatment methods. This review aimed to summarize and provide a comprehensive view on several less invasive and less time-consuming treatment options, which include hyaluronic acid and botulinum toxin injections, lip repositioning surgery (with various modifications, including laser usage), crown lengthening procedures, gingivectomies as well as other methods.

2. Characteristics of identified treatment methods

a. Botulinum toxin A injections

The perioral muscles can present hypercontractility and hyperactivity, leading to a gummy smile. Botulinum toxin is used to prevent and reverse this condition, by injection into perioral muscles (Durnel, 2019). Derived from the bacterium *Clostridium botulinum*, Botox paralyzes muscles by preventing presynaptic acetylcholine from being released at the neuromuscular junction. After three to six months, muscular activity resumes to initial parameters, after a gradual re-increase in contractility (Zenginski et al.2022). Injections with botulinum toxin can be considered a viable treatment when the patient presents at least one of the following situations: the main cause of the gingival smile is muscle hyperactivity, the patient opts for a less invasive treatment option, the patient requires a temporary treatment option or if the treatment is complementary to surgical therapy (Nasr et al.2015).

According to Duruel et al.(2019) and Roko-Sanchis et al.(2023) the advantage of this method is a therapeutic solution that offers reproducible results, can represent an adjunct in the therapeutic decision due to the possibility of previewing the results of a permanent treatment, is a solution with temporary or repeated use over time, is minimally invasive, painless and presents minimal risk of complications.

The disadvantages of this therapeutic solution are given by the limited time action of botulinum toxin and the need for reintervention, the impossibility of using botulin toxin in the therapy of gingival smile in certain etiologies with indication of surgical treatment (severe vertical maxillary excess, passive tooth rash, excessive and/or hypertrophic gingival tissue) as Nasr et al.(2015) are stating. Another disadvantage is the side effects derived from the poor injection technique or from the too large volume injected, namely the adverse effects of the type of asymmetrical smile, the collapse of the oral commissure, leading to a sad appearance of the patient, the elongation of the upper lip, the protrusion of the lower lip (Nasr et al.2015).

b. Lip repositioning surgery

Lip repositioning surgery can be used to address excessive gingival exposure when the etiology is slight maxillary vertical excess or a hypermobile lip. Repositioning the lips shorten the

vestibule by removing a mucosal tissue strip, thus limiting the muscle traction exercised by the levator muscles of the upper lip . The amount of mucosa to be excised is calculated as “two times the amount of gingival expo(Ishida et al., 2010) sure” (Gonzales-Medina et al, 2021). Consequently, it reduces gum exposure during smiling. The procedure can be used complementarily with the extension of the crown, with gingivectomy or with injections of botulinum toxin. Repositioning the lips can be done by various methods (using a scalpel, electrocautery or laser). In a literature review, Mendoza-Geng et al.(2022) identified 6 changes to the conventional technique of repositioning the upper lip: preservation of the labial frenulum, concomitant myotomies, muscular dissection, muscle isolation through sutures, realizing of traction of the levator muscles through periosteal sutures and the adjuvant use of botulinum toxin.

Patients may prefer this treatment approach over orthognathic surgery because of its reduced morbidity and lower expenses. It is thought to be safe and has few side effects (Foudah, 2019). In addition, according to Foudah (2019) the short post-surgical recuperation time is also an advantage.

Regarding the contraindications to the treatment and potential side effects, insufficient fixed gum height, a tiny vestibule, an excess of gingival exposure more than 4-5 mm, and periodontal disease are mentioned by Tawfik et al.(2018). Patients who opt for this course of treatment may encounter the following side effects: mild soreness, postoperative tension in the upper lip causing limited mobility, oedema, ecchymosis, paresthesia, and mucocele in cases of small salivary glands (Tawfik et al.2018).

c. Crown lengthening procedures

There are multiples published studies (Mele et al.2018, Hempton and Dominici, 2010, Ulfah and Wijaksana, 2021) demonstrating that crown lengthening, as a surgical procedure, targets exposing the cervical area of the tooth and increasing coronal height, for restorative or aesthetic purposes. It is achieved by apical repositioning of gingival tissue, usually along with removing a portion of alveolar bone . Crown lengthening procedures depend on the width of the keratinized gum band, the position of the gingival margins, the position of the alveolar ridge, the location of the mucogingival junction and the possibility of concomitant restorative therapy (Pinto et al., 2015). According to Hempton and Dominici (2010) there are two treatment options for cases of modified passive eruption are: a simple gingivectomy to expose the hidden anatomy or a full-thickness apical repositioned flap, with or without bone resection surgery.

This procedure is considered a safe and predictable approach for altered passive eruption and subsequent gummy smile. It is a less-invasive procedure compared to other surgical options and the recovery of the patient is easier (Hempton and Dominici, 2010, Ulfah and Wijaksana, 2021).

However, two studies, published by Smith et al (2023) and Aroni et al.(2019) display some of the technique’s disadvantages, including postoperative discomfort, pain, and local inflammation. There is also a risk of root exposure, increasing the risk of root caries and dental sensitivity. Some patients may experience gingival margin position changes, in time.

d. Studies on hyaluronic acid injections

Hyaluronic acid is a natural molecule with a high molecular weight, capable of holding up water, up to 1000 times its weight (Mercado-Garcia et al., 2021). Some authors (Mercado-Garcia

et al., 2021, and Germani Vieira et al, 2022) have proposed modifying the muscle contraction of perioral muscles by mechanical compression by hyaluronic acid injections, this method becoming a therapeutic option in the gingival smile. The procedure is designed to compress the lateral fibers of the levator labii superioris alaeque nasi (LLSAN), inhibiting the motility of the deep portion of the LLSAN and attenuating the lift of the upper lip during smiling.

According to Hsien-Li et al, 2019, the advantages, offered by hyaluronic acid fillers treatment, are represented by the procedural safety, predictability, and comfort for the patient. It offers a local volumetric augmentation which can contribute to aesthetic improvement, with visible results immediately post-intervention, lasting up to 6-8 months (Mercado-Garcia et al., 2021) . However, this therapeutic option can only be used in cases of reduced gingival exposure and can only be performed by experienced clinicians (Germani Vieira et al, 2022) .

e. Gingivectomy

As stated by Meghana et al. (2021), gingivectomy, associated or not with gingivoplasty, is a periodontal surgical treatment targeting gingival hyperplasia caused by other causes than plaque accumulation and oral hygiene deficiencies.

Studies published by Mossaad et al. (2021) and Meghana et al. (2023) propose various instruments to be used for exposing the enamel-cement junction and to obtain a physiognomic and physiologically compatible gingival contour and profile, such as scalpels, electrocautery, lasers. This procedure can also benefit from digital planning and surgical guides.

According to Meghana et al.(2023), the main advantage of this method is represented by the minimal invasiveness of the procedure and the rapid recovery of the patient. Regarding the disadvantages, Meghana et al.(2023) mention that they are similar to other periodontal surgical procedures (such as crown lengthening). In addition, relapse due to gingival re-growth is possible, depending on the causes of the hyperplasia.

3. Comprehensive analysis of gummy smile treatment options

The present research provides novel insights into the management of gummy smiles by focusing on both minimally invasive treatments, as well with surgical techniques. It reviews recent advancements in treatment options beyond traditional orthognathic surgery and orthodontics, presenting an updated perspective on using botulinum toxin, surgical lip repositioning, and other innovative techniques that offer less downtime and potential for temporary or reversible results. This perspective is particularly relevant as it addresses the growing demand for aesthetic improvements with minimal patient discomfort and recovery time.

a. Impact of geographic and ethnic differences on treatment choices

The geographical diversity of the study populations featured in this review highlights significant differences in treatment approaches for gummy smiles, which are often influenced by various skin phenotypes, facial musculature, as well as intra-oral soft tissues. According to Diaspro et al. (2018), treatment preferences and outcomes can vary across different ethnic groups, who may exhibit distinct characteristics such as lip fullness, gingival thickness, and muscle dynamics. These anatomical differences necessitate a tailored approach to treatment; for example, populations with thicker gingiva may respond better to surgical

interventions like gingivectomy, as opposed to botulinum toxin, which may be more effective in populations with pronounced muscle activity causing excessive lip elevation.

b. Consideration of local clinical expertise and available technologies

Furthermore, the local availability of specialized dental aesthetics clinical expertise and technologies also plays a crucial role in the choice of treatment. As noted by Monaco et al. (2004), regions with advanced cosmetic dentistry facilities are more likely to offer treatment options such as laser therapy and digital smile design, which are less invasive and can be precisely customized to individual aesthetic needs. In areas where such aesthetics-focused facilities are less available, more traditional methods like orthognathic surgery may be preferred. This geographic disparity in available treatments emphasizes the need for developing adaptable treatment protocols that can provide optimal outcomes across various settings.

In addition to the minimally invasive and surgical options discussed, gingivectomy stands out as a particularly effective surgical method for treating excessive gingival display where non-surgical methods are not an option. This treatment is especially beneficial for patients with thicker gingival tissues or those who require more substantial corrective measures to achieve an aesthetically pleasing smile. The precision of the procedure allows for tailored gingival contours that enhance the overall harmony and balance of the smile, significantly improving patient outcomes. Studies, including those by Diaspro et al. (2018), have documented high rates of patient satisfaction post-gingivectomy, attributing it to the procedure's ability to provide lasting and visually appealing results. This underlines gingivectomy not just as a treatment option, but as a cornerstone technique in the spectrum of gummy smile corrections

c. Adaptation of treatment protocols to local aesthetic preferences

In addition, esthetical preferences influenced by cultural norms within different geographical areas also influence the choice of gummy smile treatments. The research performed by Zengiski et al. (2022) illustrates how patient expectations and cultural definitions of an 'ideal smile' vary, affecting the popularity and acceptance of certain treatments. In some cultures, a slight gummy smile may be considered attractive or a non-issue, reducing the demand for corrective procedures. Such cultural perceptions must be integrated into treatment planning to ensure that the interventions align not only with clinical indicators but also with patient satisfaction and acceptance, thereby enhancing the overall success of the treatments.

d. Comparative efficacy and patient-centered outcomes

In response to the need for a more comprehensive analysis, this research investigated also the comparative efficacy of various treatment modalities for gummy smiles, evaluating not just clinical outcomes but also patient-centered metrics such as personal satisfaction, recovery time, and psychological impact. For instance, while botulinum toxin injections offer a non-invasive, quick solution with minimal downtime, they require repeated sessions to maintain the aesthetic result, which might affect long-term patient satisfaction and cost-effectiveness (Zengiski et al., 2022). Conversely, surgical options like crown lengthening and lip repositioning, though more invasive, provide permanent, long-term solutions which may lead to higher patient satisfaction due to their durability (Diaspro et al., 2018). This

comparative analysis is important for clinicians, to make informed decisions that align with both the clinical presentation and the patient's lifestyle

e. Integrative and personalized treatment approaches

Based on the findings of this literature review, a discussion on the integration of multidisciplinary treatment approaches is also outlined; therefore, depending on the clinical case, combining different techniques can optimize outcomes for individual patients. For example, the integration of digital smile design technology can help in planning and visualizing the end results of combined therapies such as laser gingivectomy followed by lip repositioning, ensuring that the treatments are not only effective but also align precisely with patient expectations and aesthetic goals (Monaco et al., 2004). This personalized approach underscores the importance of a patient-centric model in cosmetic dentistry, where the objective is to achieve a harmonious balance between clinical efficacy and patient desires, thereby improving both the functional and psychological outcomes of the treatment (Venugopal et al., 2024)

Furthermore, the integration of gingivectomy within a multidisciplinary treatment framework can be particularly potent. For example, combining gingivectomy with procedures like lip repositioning or botulinum toxin applications can address both excessive gingival display and hyperactive lip mobility simultaneously, providing a comprehensive solution that caters to the complex aesthetic and functional needs of patients. The combination of these techniques, guided by digital smile design, allows for precise planning and execution, ensuring outcomes that align closely with patient expectations and enhance satisfaction. This integrative approach not only optimizes aesthetic outcomes but also underscores the adaptability and efficacy of combining traditional surgical methods with modern technological advancements in treatment planning (Monaco et al., 2004).

4. Study limitations and strengths

One of the limitations of this study is presented by the heterogeneous nature of included studies, when regarding both study designs and treatment methods. The high variability of possible etiologies in gummy smile translates into an even higher variability of treatment methods, which ultimately depend on the individual patient's medical context and expectations from the treatment. Therefore, there is no treatment method universally effective in gummy smile cases, nor is there a treatment method that works invariably for all cases of gummy smile derived from a specific aetiology. Additionally, the various classifications for gummy smile and the lack of a single method of assessment mean that studies on the subject have various means of cases, controls and outcome assessments available. The severity of gummy smile largely depends on the patients' perception and levels of dissatisfaction, which adds a subjective factor to the evaluation of treatment outcomes, thus complicating it. The individual patients' perception of this pathology and its severity could also reflect in the chosen treatment methods, which in turn lead to a disbalance in literature, with many studies available on some treatment methods, with few on others. The evidence supports levels of the studies also seem to vary in accordance with treatment options. In addition, many studies have small sample sizes and lack comprehensive longitudinal follow-up. These limitations represent barriers in the

elaboration of definite conclusions and for the development of standardized therapeutic algorithms.

This study also presented some several notable strengths. Firstly, it adhered to the PRISMA protocols, modified for scoping reviews, ensuring a transparent approach to the process of reviewing. Secondly, the comprehensive and broad search strategy ensured the identification of a high number of the most recent studies on the subject. This was instrumental in providing a wide perspective on existing less-invasive treatment methods for excessive gingival display. These results were summarized in detail, and discussed based on treatment methods, with added information on the advantages and disadvantages of each method, thus transforming this study in a valuable insight on the subject. The meticulous approach of this study meant that it reached its objectives, providing an extended overview and a basis for further research in the field.

Conclusions

Gummy smile can become a treatment challenge for the dental practitioner. The etiology of gummy smile and patients' desires should drive the treatment plan for gummy smile, to ensure a predictable and satisfactory result for both the dentist and the patient. Alternative, less-invasive surgical treatment methods or other minimally invasive non-surgical methods are worth exploring as standalone therapeutic options or integrated with interdisciplinary approaches, taking into consideration the individual context of each patient, as each method presents advantages and disadvantages. The recent literature reveals a growing interest in these methods and presents a range of therapeutic techniques addressing both the aesthetic and the functional concerns of excessive gingival display. Botulinum toxin A injections have been widely studied as a therapy for gummy smile, as well as lip repositioning surgical techniques and their variations, including laser-assisted surgery. The rest of the methods have not been under focus as much as the abovementioned, however they are still present and integrated into treatment plans. Further studies with longitudinal follow-up could provide a valuable influx of data for predictability of results, thus raising awareness and increasing availability of these treatment methods for excessive gingival display.

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